Study on the Spatial Distribution of Enterprise Companies and Supporting Facilities in Beijing's Zhongguancun Area Based on POI Data

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Abstract: This study conducts an analysis of the overall Points of Interest (POI) in the Zhongguancun area of Beijing. It focuses on extracting all enterprise companies within this area as research subjects. Leveraging the background of big data related to POI, it integrates information on supporting facilities for enterprise companies in Zhongguancun, including the distribution of hotels, convenience stores, coffee shops, and gyms. Through point-based analysis and kernel density analysis of these four types of supporting facilities, and considering the needs of the target audience, primarily office workers, this study comprehensively analyzes the improvement directions for supporting facilities in the Zhongguancun area.

1. Introduction

1.1 Background and Conceptual Definition of the Study

In the field of modern architectural and urban design, the use of advanced spatial analysis tools to enhance design effectiveness has become an essential task. Among these tools, Point of Interest (POI) and Kernel Density analysis play crucial roles. For instance, research on urban environment and climate analyzed the relationship and relative importance between urban surface temperature and ecological infrastructure, building volume, and multi-scale (500, 1000, 2000 m) POI density using methods like Pearson correlation analysis and univariate regression analysis. The results demonstrated the significant cooling effect of ecological infrastructure, and the positive correlation of building volume and POI density with LST1. Similarly, studies in the intersection of urban planning and geospatial technology (Hu et al., 2019) [1]successfully identified and analyzed the characteristics and spatial distribution of different functional zones in the city through the analysis of POI functional type frequency density and ratio using data provided by the Amap application software2. In transportation-related research (Ye et al., 2020)[2], such techniques were used to analyze the impact of business districts in Chongqing on traffic congestion, validating the correctness of the "trickle-down effect"3. In a study by Hou et al. (2021)[3], the kernel density estimation method was employed to examine 20 factors related to dimensions like healthcare, education, transportation, and economy as a set for selecting livable residential locations. This was followed by functionalities like real estate information retrieval, POI analysis, kernel density analysis, statistical analysis, and

livable residential evaluation.

POI emphasizes specific locations in space, allowing designs to be more closely aligned with human needs and activities. On the other hand, Kernel Density analysis considers the distribution of point elements in space, enabling designs to better adapt to the characteristics of crowd movement and activity aggregation[4]. This study extracts all enterprise companies within the Zhongguancun area as research subjects and, based on the background of POI big data[5], integrates information about supporting facilities for enterprise companies in Zhongguancun, including the distribution of hotels, convenience stores, coffee shops, and gyms. Through point-based analysis and kernel density analysis of these four types of supporting facilities, the study identifies improvement directions for supporting facilities in the Zhongguancun area[6], taking into account the primary service audience of enterprise companies - office workers.

This study builds on previous research and introduces the following innovations:

1) Selecting the enterprise infrastructure in the Zhongguancun area as the research subject. This area is renowned as a crucial hub for Chinese technological innovation, gathering numerous high-tech companies and innovation institutions6. The collective of enterprise companies within the Zhongguancun area exhibits unique economic and technological characteristics, covering various fields from startups to international tech giants, forming a complex yet highly interconnected technological ecosystem7. Choosing the Zhongguancun area as the research subject stems from its distinct position in the realms of technology and innovation, providing a special background and data foundation for this study.

2) This study places particular emphasis on enterprise infrastructure, including the distribution of hotels, convenience stores, coffee shops, and gyms. This is a relatively unique focus in urban research.

2. Research Methodology

The scope of this study centers around the Zhongguancun Science Park, extending from Beisihuan West Road to Haidian Bridge in the north, and from Haidian South Road in the south. The eastern and western boundaries are formed by Zhongguancun Street and Suzhou Street, respectively, enclosing an approximately square area. Within this area, numerous enterprise companies are located, such as China Electronics Building, CEIEC International, and Tianchuang Technology Building, among others. In order to better serve the personnel working in Zhongguancun and create a more comfortable living environment for them, POI data was utilized to analyze the distribution of points within this area. Based on the distribution of enterprise companies and the point distribution of surrounding supporting facilities, deficiencies in the distribution of supporting facilities were identified. This information was then used to propose future areas for the placement of these facilities.

The author utilized GIS ArcMap in conjunction with the coordinates of Zhongguancun points to compile a distribution map of POIs in the Zhongguancun area (see Figure 1).

From this, it is evident that there are a total of 2883 POIs in the western section of Zhongguancun. Upon examining the distribution map, it is observed that they are relatively concentrated along Danleng Street and Suzhou Street. Therefore, it can be inferred from the map that the areas with denser activities within Zhongguancun are in close proximity to Danleng Street and Suzhou Street. Furthermore, by conducting POI analysis on the overall area's other supporting facilities, it was verified whether they adhere to this distribution pattern, leading to the formulation of improvement strategies.
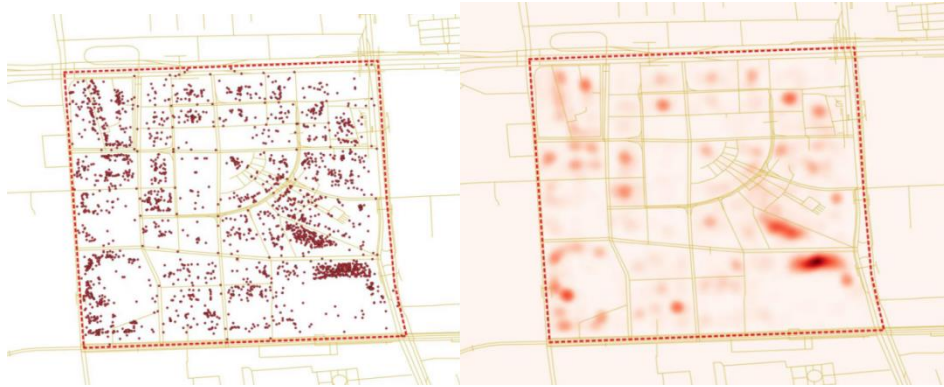
Figure 1: General map of POI points in Zhongguancun

3. Data Analysis

3.1 POI Point Analysis

We selected "Enterprise Companies" within the Zhongguancun area and their corresponding supporting facilities: "Hotels," "Convenience Stores," "Coffee Shops," and "Gyms." The data for each category was used to create point distribution maps, providing a visual representation of the distribution of enterprise companies and their supporting facilities. This facilitates the identification and summarization of patterns. (Figure 2)

Figure 2: Distribution of Zhongguancun Enterprise Companies

There are a total of 52 hotels in Zhongguancun West, which are more centrally located in the western and southern parts of the Zhongguancun West site (Figure 3).

Figure 3: Distribution of hotels in Zhongguancun

There are 53 convenience stores in Zhongguancun West, which are more evenly distributed in general. Compared with the distribution of corporate companies in the parcel, the number of convenience stores in the northern part of the parcel is less and the number of corporate companies is more (Figure 4).

Figure 4: Distribution of convenience stores in Zhongguancun

There are a total of 38 coffee shops in Zhongguancun West, which are more evenly distributed in general. Compared with the distribution of enterprise companies in the plot, the number of coffee shops in the center and the south of the plot is smaller, and the number of company companies is higher (Figure 5).

Figure 5: Distribution of coffee shops in Zhongguancun

Zhongguancun West has a total of 34 fitness centers, the overall distribution is more concentrated in the western part of the parcel, and the distribution of corporate companies within the parcel, compared to the northern part of the parcel, the number of fitness centers is less, and the number of corporate companies is more (Figure 6).
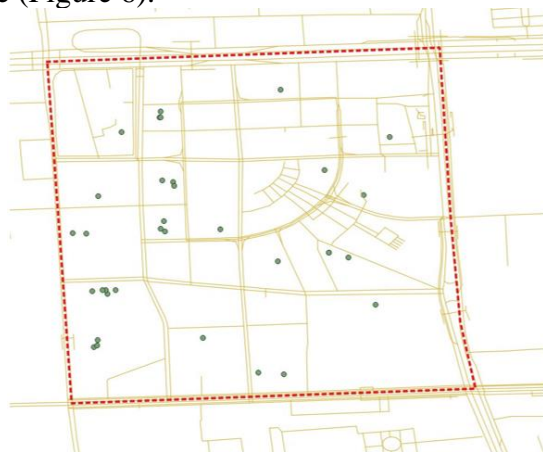

Figure 6: Distribution of gyms in Zhongguancun

In summary, the POI map analysis shows that in the Zhongguancun area, which is centered on enterprise companies, the distribution of hotels is mostly concentrated in the west and the south. Convenience stores and coffee shops are evenly distributed in general, but there are fewer of them in the middle and the south. The northern part lacks resources in terms of gyms.

3.2 Kernel Density Analysis of Enterprise Companies and Supporting Facilities in Zhongguancun

Kernel density plots illustrate the frequency of occurrences in a dataset, providing a visual representation of the "density" of data points on a coordinate axis. These plots use smoothed curves to display the data distribution, with higher "peaks" indicating denser areas. The author conducted kernel density analysis on enterprise companies and their supporting facilities within the Zhongguancun area. The aim was to infer activity patterns and density within this region based on the kernel density analysis plots (see Figures 7-11). This inference allows for the identification of potential issues with the distribution of supporting facilities within the area.

Figure 7: Kernel density map of enterprise companies

Figure 8: Hotel nuclear density map   Figure 9: Kernel Density Map for Convenience Stores

Figure 10: Kernel density map of coffee shops   Figure 11: Kernel density map for gyms

Based on the analysis of the kernel density plots above, it can be observed that areas with high activity density near enterprise companies are concentrated in the northwest, while the southeast

exhibits lower activity density. The distribution of hotels shows a complementary relationship with areas of high activity around enterprise companies, indicating a good alignment between hotels and enterprise activities, suggesting a comfortable relationship. Convenience stores are primarily concentrated in the northwest and southeast regions, with distinct gaps in the north and center. Coffee shops demonstrate a relatively even density distribution, but the southern region appears to be less active. Gym facilities are predominantly situated along Suzhou Street, with fewer facilities on the northern side.

3.3 Summary

1) Distribution of Enterprise Companies: Enterprise companies in the western section of Zhongguancun are generally evenly distributed, but areas with higher activity density are observed in the northwest and southeast regions, suggesting these areas may serve as hotspots for activities.

2) Distribution of Hotels: Hotels are primarily located in the southwest and northwest of the western section of Zhongguancun, complementing the distribution of enterprise companies. This suggests that the layout of hotels around enterprise activity hotspots is reasonably balanced, facilitating business travel.

3) Distribution of Convenience Stores: Convenience stores are relatively evenly distributed, but there are noticeable gaps in the northern and central areas. Further considerations may be needed for the layout strategy of convenience stores.

4) Distribution of Coffee Shops: The density distribution of coffee shops is relatively uniform, although the southern area exhibits slightly lower activity density, presenting a potential business opportunity.

5) Distribution of Gyms: Gyms are mainly concentrated along Suzhou Street in the western section of Zhongguancun, with a relative lack of fitness facilities in the north. Consideration may be given to increasing relevant facilities in this area.

In conclusion, based on the distribution of enterprise companies and supporting facilities in the western section of Zhongguancun, it is recommended to add convenience stores and fitness facilities in the north, consider adding coffee shops in the south, and thereby cater to the needs of residents and employees in different areas, further enhancing the livability and convenience of business activities in the region. Additionally, the layout of hotels complements the distribution of enterprise companies, aligning with the requirements of business travel.

4. Conclusion

Based on the POI data analysis of enterprise companies and supporting facilities in Zhongguancun, it can be concluded that there is a good match between enterprise companies and supporting facilities in the Zhongguancun Science Park. However, there are slight deviations in the placement of convenience stores and coffee shops compared to the activity areas of enterprise company employees. Most gyms align with the activity areas of enterprise companies, but there are still some areas without intersection.

Below are some improvement strategies and plans derived from the analysis of POI data and kernel density analysis:

1) Addition of Convenience Stores and Fitness Facilities:

Convenience stores and fitness centers should be added in the northern area to meet the daily needs and fitness activities of both enterprise employees and residents.

2) Expansion of Coffee Shops:

Given the relative lack of coffee shops in the southern area, it is advisable to consider expanding the number of coffee shops in this region to enhance community activity and provide residents with

leisure spaces.

3) Coordinated Planning of Enterprises and Supporting Facilities:

Since the distribution of hotels and enterprise companies complements each other, further efforts should be made to strengthen the coordination and planning between enterprises and hotels, ensuring that the accommodation needs of business personnel are met.

4) Diversification of Supporting Facilities:

In the planning of supporting facilities, consideration should be given to introducing more diverse options, such as providing a variety of dining and shopping choices, to meet the needs of different demographics.

5) Establishment of a Technology-Supported Platform:

It is recommended to establish a technology-supported platform that integrates relevant data and analytical tools, providing stakeholders such as decision-makers, planners, and businesses with the means to conduct planning and decision-making in a more scientific manner.

6) Sustainability Considerations:

Environmental and sustainability factors should be taken into account in the improvement strategies. This may include initiatives like increasing green spaces and enhancing the convenience of public transportation to promote ecological improvement.

In summary, due to the significant concentration of enterprise companies in the northern part of the selected area, but with a shortage of convenience stores in the same area, it is recommended to add convenience stores in the northern section. Similarly, the central and southeastern areas of the selected zone lack coffee shop arrangements and should be addressed in future planning. Given the high intensity of intellectual work and prolonged sedentary positions, fitness centers play a crucial role. Therefore, corresponding fitness facilities should be established in areas with dense enterprise company activities. The northern area, being a hub of intense enterprise company activities, lacks adequate fitness facilities, and thus, fitness centers should be added in this region.

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